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Ergonomic Considerations in Glovebox Design

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Ergonomics

Ergonomics  Human Factors

Fitting a job to a person!

 Productivity and Comfort

 MSD Injury and Human Error Risk

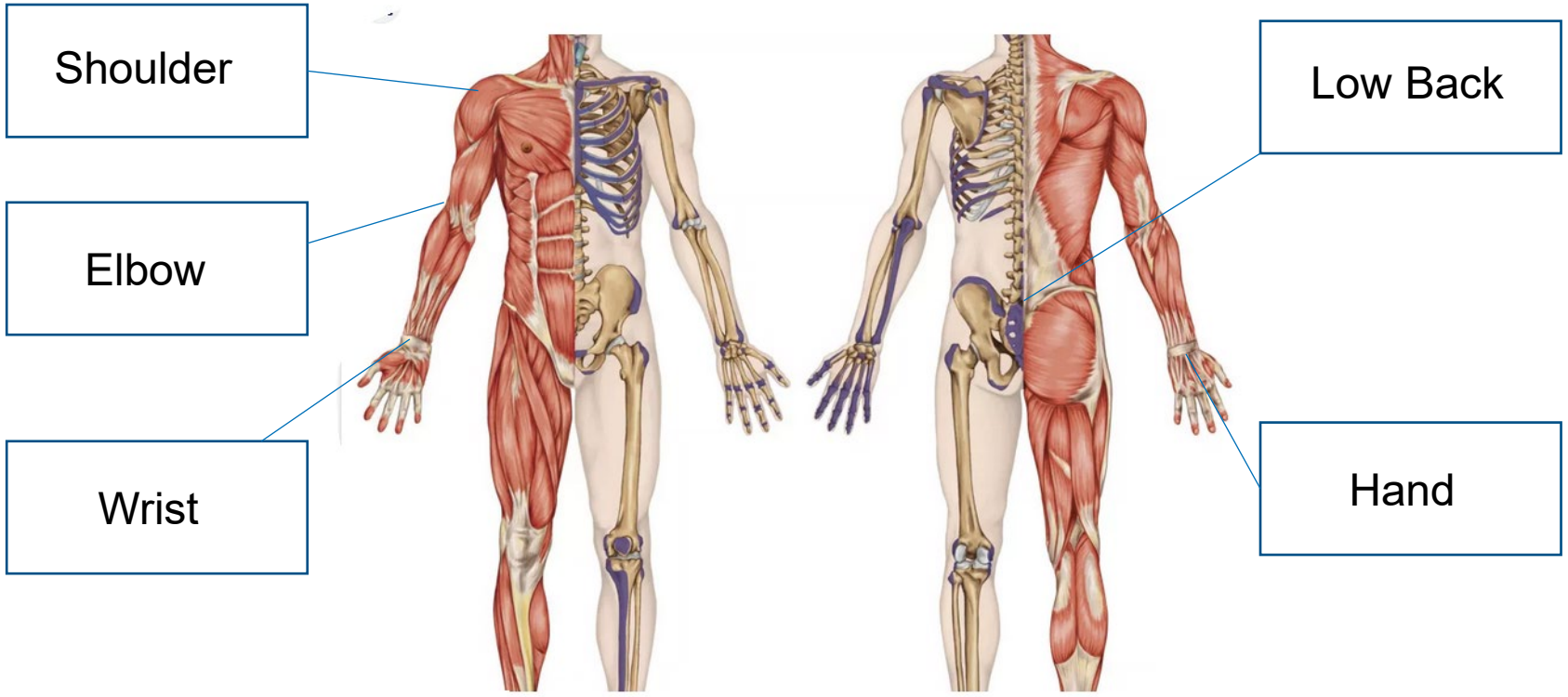
Ergonomic Risk Factors

- Duration
- Repetition
- Posture (awkward)
- Forceful exertions
- Vibration
- Environment – cold/hot temps
- Physiological and Psychological Factors

Musculoskeletal Disorders (MSDs)

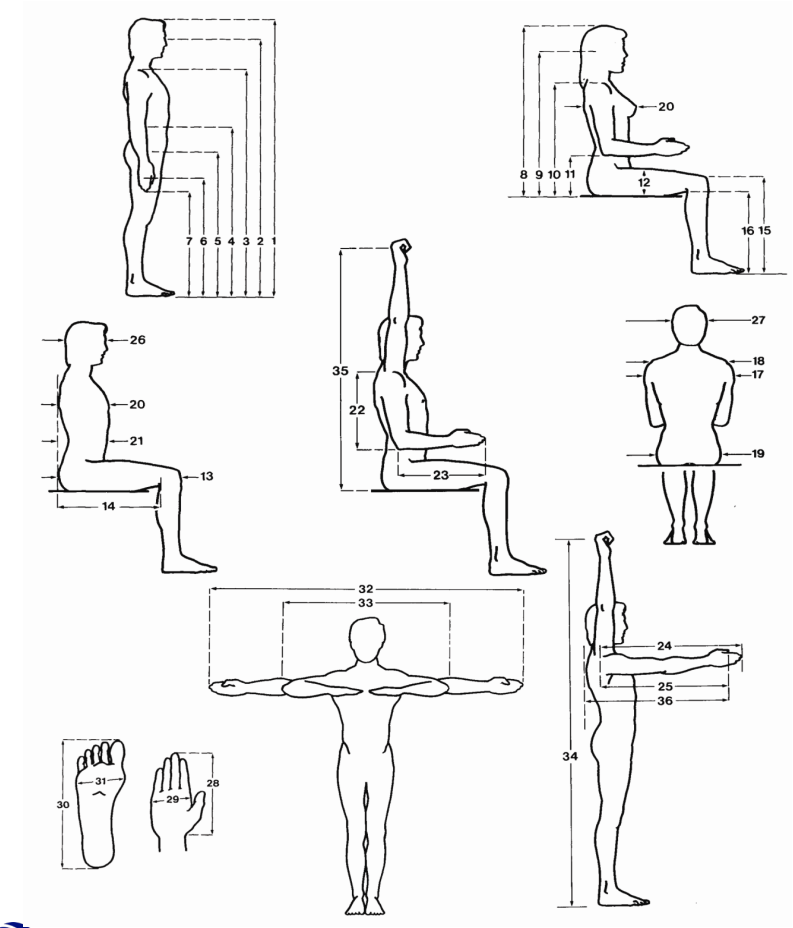
Injuries or disorders that can affect the muscles, nerves, tendons, joints and cartilage in your upper and lower limbs, neck and lower back.

High Risk for GB Ergo Injuries (Top 5)



Anthropometry

- Define who users will be in terms of gender anthropometric design ranges
- Design to fit a user population ranging from 5th percentile female through 95th percentile male, unless otherwise specified.



Measures - Inches	Males				Females			
	5th	50th	95th	1 S.D.	5th	50th	95th	1 S.D.
1. Stature	64.6	69.1	73.6	2.8	59.8	64.0	68.1	2.5
2. Eye Height	62.8	67.3	71.9	2.8	55.9	60.0	64.2	2.5
3. Shoulder Height	52.4	56.7	61.0	2.6	48.2	52.2	56.1	2.4
4. Elbow Height	40.2	43.5	46.9	2.1	37.2	40.2	43.1	1.9
5. Hip Height	32.9	36.0	39.2	2.0	29.9	32.9	35.8	1.8
6. Knuckle Height	27.6	30.1	32.7	1.6	26.4	28.7	31.1	1.5
7. Fingertip Height	23.4	26.0	28.5	1.5	22.2	24.8	27.4	1.6
8. Sitting Height	33.7	36.0	38.4	1.4	31.5	33.9	36.2	1.4
9. Sitting Eye Height	29.1	31.5	33.9	1.4	27.2	29.5	31.9	1.4
10. Sitting Shoulder Height	21.5	23.6	25.8	1.3	20.1	22.2	24.4	1.3
11. Sitting Elbow Height	7.7	9.6	11.6	1.2	7.3	9.3	11.2	1.1
12. Thigh Thickness	5.3	6.3	7.3	0.6	4.9	6.1	7.3	0.7
13. Tailbone-Knee Length	21.7	23.6	25.6	1.2	20.7	22.6	24.6	1.2
14. Tailbone-Popliteal Length	17.5	19.7	21.9	1.3	17.3	19.3	21.3	1.2
15. Knee Height	19.5	21.7	23.8	1.3	18.1	19.9	21.7	1.1
16. Popliteal height	15.6	17.5	19.5	1.1	14.2	15.9	17.7	1.1
17. Shoulder Breadth (bideltoid)	16.7	18.5	20.3	1.1	14.2	15.7	17.3	1.0
18. Shoulder Breadth (biacromial)	14.4	15.7	17.1	0.8	13.0	14.2	15.4	0.7
19. Hip Breadth	12.2	14.2	16.1	1.2	12.2	14.8	17.3	1.5
20. Chest (Bust) Depth	8.7	10.0	11.4	0.9	8.3	10.0	11.8	1.1
21. Abdominal Depth	8.7	10.8	13.0	1.3	8.3	10.2	12.2	1.2
22. Shoulder-Elbow Length	13.0	14.4	15.7	0.8	12.0	13.2	14.4	0.7
23. Elbow-Fingertip Length	17.5	18.9	20.3	0.8	15.7	17.1	18.5	0.8
24. Upper Limb Length	28.7	31.1	33.5	1.4	25.8	28.1	30.5	1.4
25. Shoulder-Grip Length	24.2	26.4	28.5	1.3	22.0	24.0	26.0	1.2
26. Head Length	7.1	7.7	8.3	0.3	6.5	7.1	7.7	0.3
27. Head Breadth	5.7	6.1	6.5	0.2	5.3	5.7	6.1	0.2
28. Hand Length	6.9	7.5	8.1	0.4	6.3	6.9	7.5	0.4
29. Hand Breadth	3.1	3.5	3.9	0.2	2.6	3.0	3.3	0.2
30. Foot Length	9.4	10.4	11.4	0.6	8.7	9.4	10.2	0.5
31. Foot Breadth	3.5	3.9	4.3	0.2	3.1	3.5	3.9	0.2
32. Span	65.7	71.3	76.8	3.3	59.3	64.0	68.7	2.9
33. Elbow Span	34.4	37.6	40.7	1.9	31.1	33.9	36.6	1.7
34. Vertical Grip Reach (Standing)	76.8	81.9	87.0	3.1	71.1	75.8	80.5	2.9
35. Vertical Grip Reach (Sitting)	45.5	49.4	53.3	2.4	42.1	45.7	49.2	2.2
36. Forward Grip Reach	28.5	30.9	33.3	1.4	25.8	28.0	30.1	1.3
37. Body Weight *(in pounds)*	121.0	171.6	224.4	30.8	90.2	143.0	195.8	33.0

Ideal Glovebox Worker Basic Dimensions

- Overall Height: 5’10” (178cm) (Female 95th / Male 60th)
- Arm Length: 28” (Female 99th / Male 85th)
- Shoulder Width: 18” (Female 95th / Male 65th)

Glovebox Design Considerations

- Gloveport Centerline Distance
- Gloveport Height – Centerline to Floor
- Window Configurations
- Glovebox Face Angle
- Spool Location
- Pencil Drop location
- Work Envelope
- Lighting
- Maintenance

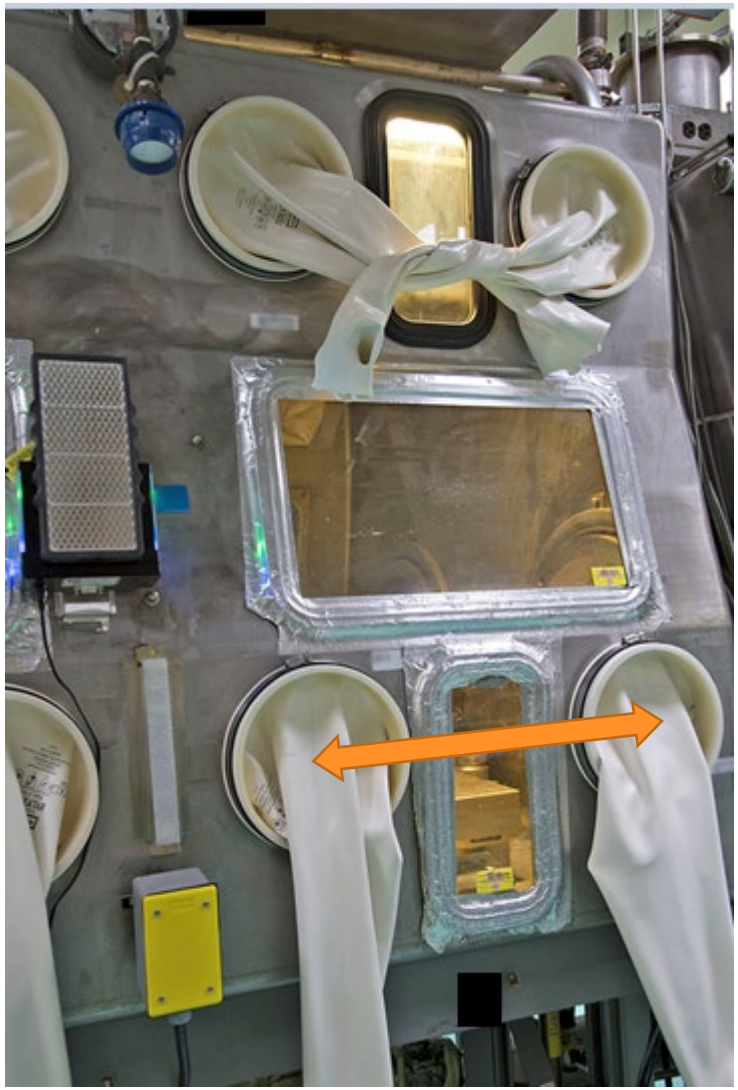
Gloveport Centerline

Spacing between gloveport centerlines:

- 15-18 inches
- Nominal 16.5

- Full Visibility windows use the nominal distance or 17”

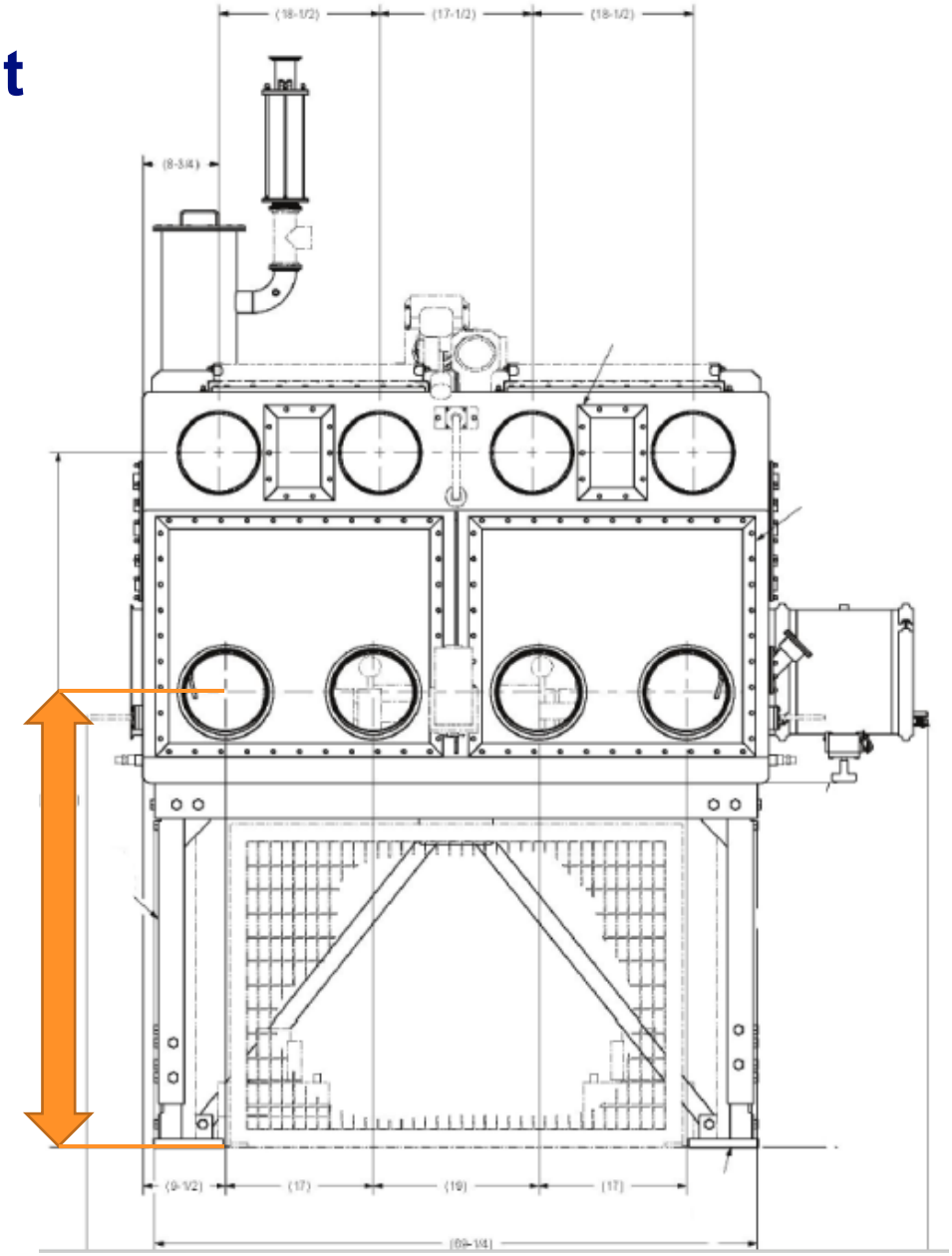
- Diamond Windows use the nominal distance or 17”



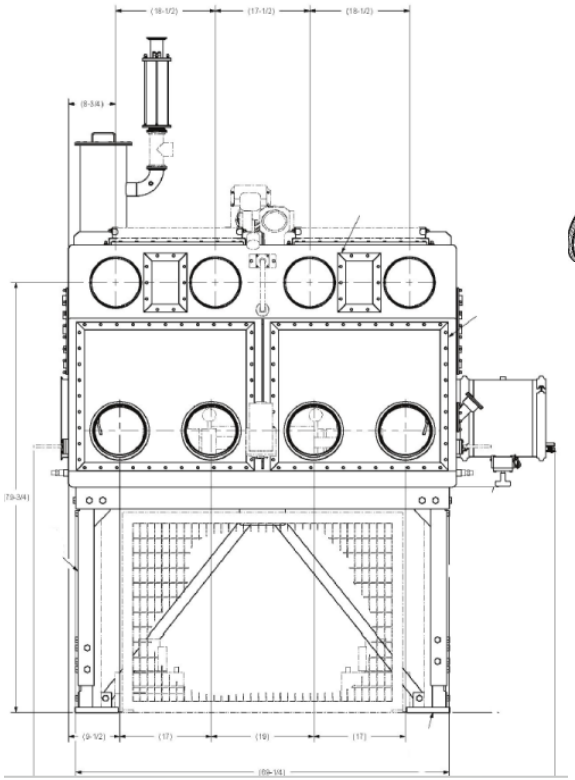
Gloveport Centerline Height

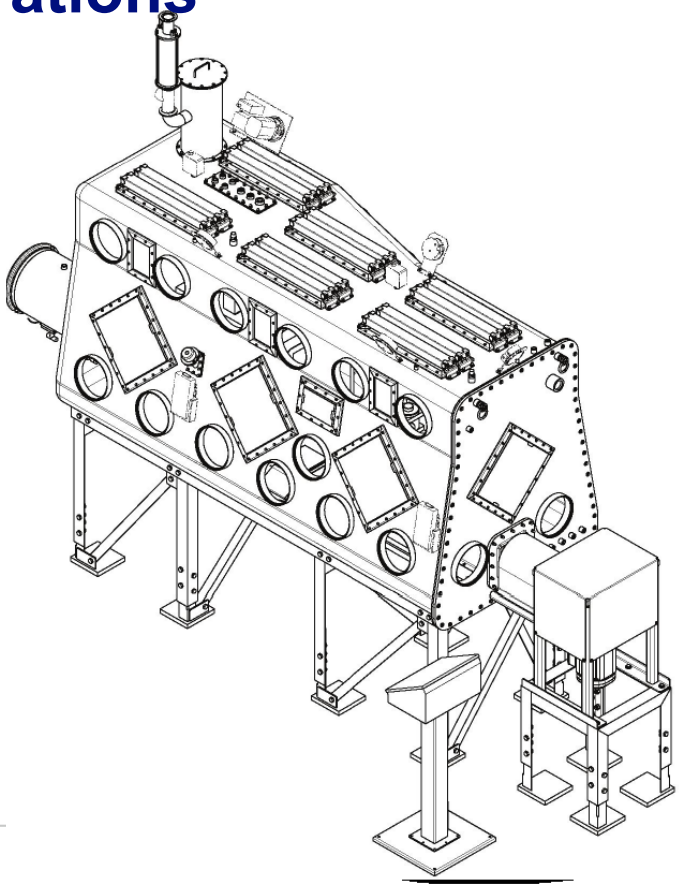
Centerline height for standing workers

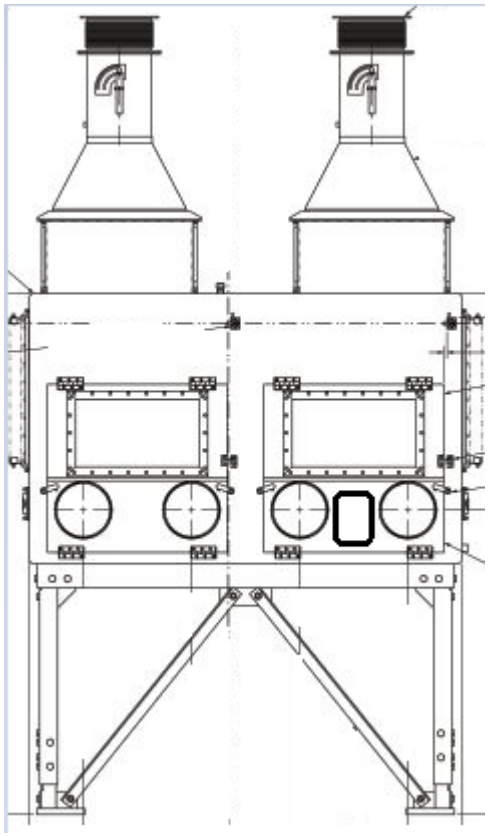
- normally be 48 inches (range from 48-52 inches) from finish floor
- multi-adjustable footstools to accommodate range of workers



Window Considerations







Full Visibility is the ideal window, followed by diamonds, and then rectangular.

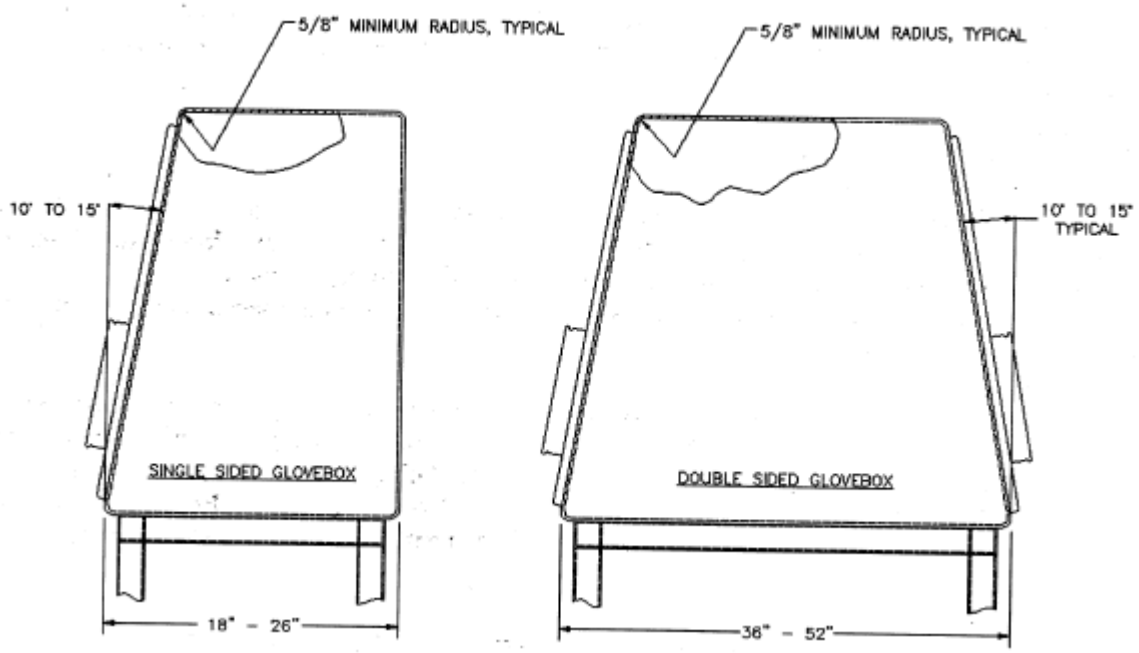
far left image is a hood with a drawn in small window for demonstration only

Glovebox Shell Angle

The window angle should be 10-15 degrees.

This ensures viewing ease for operators.

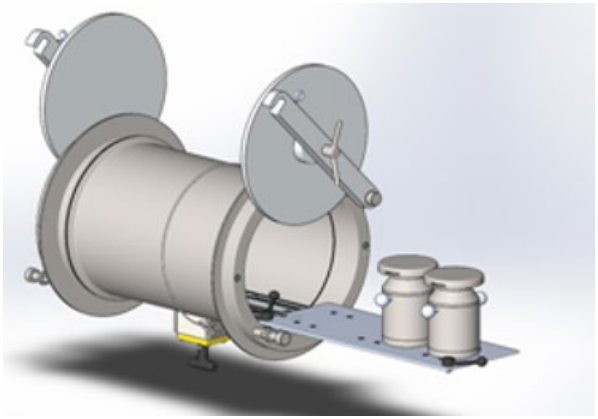
Boxes with different types of windows, i.e. diamond or full visibility, are often on the low end of the angle range due to constructability.

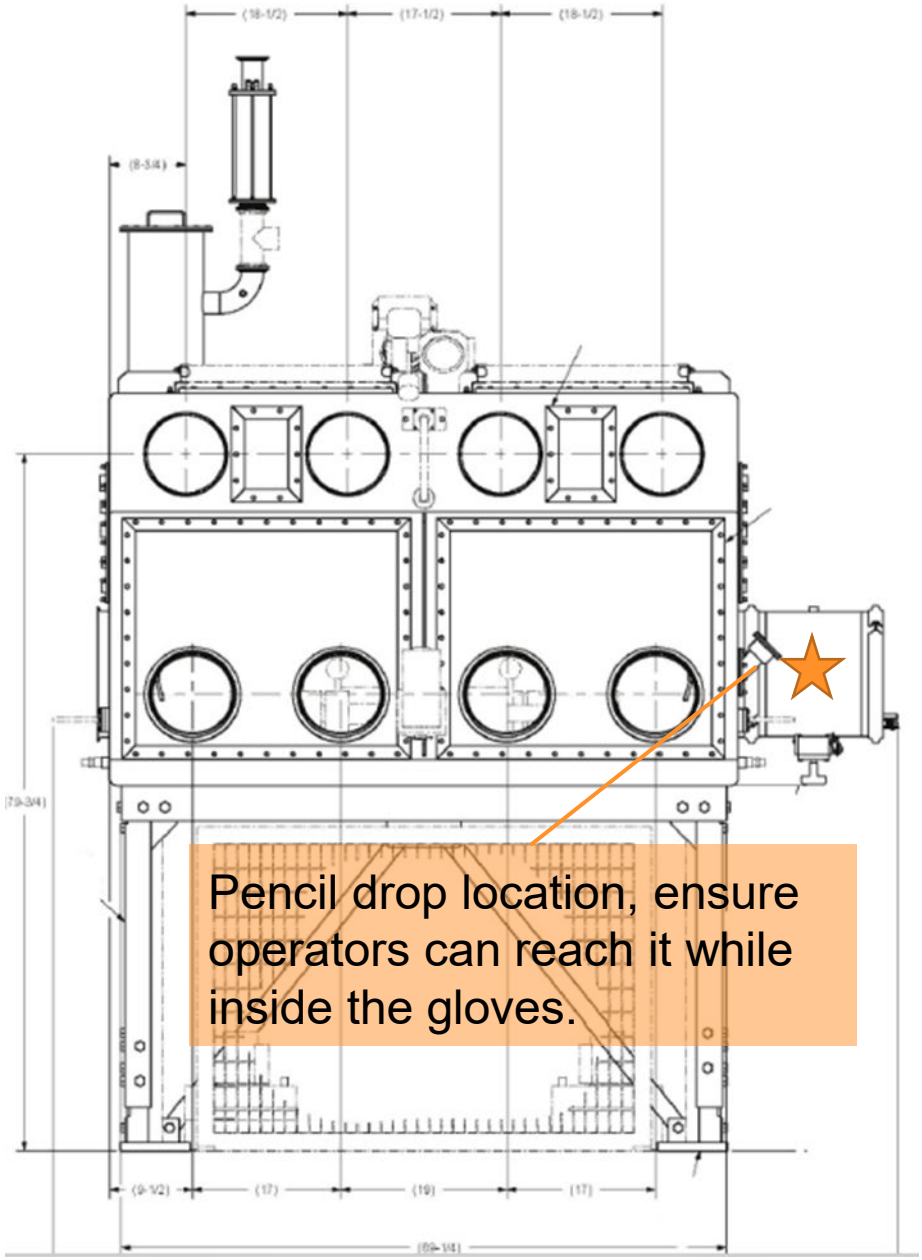


Spool Location

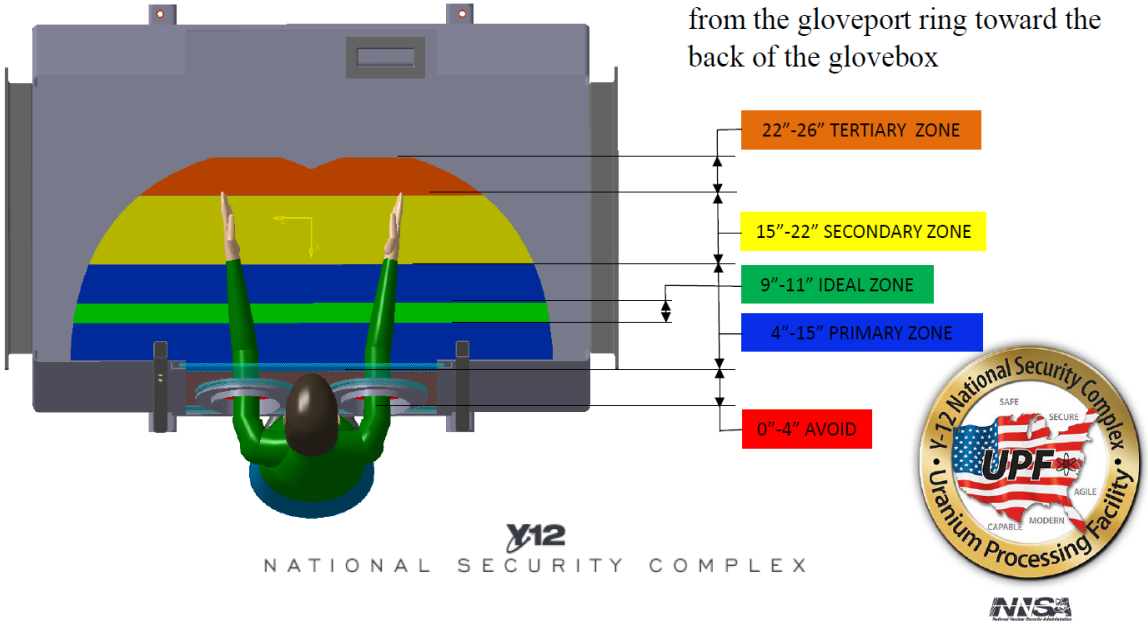
Spool should be 11-14 inches centerline to the front face of the glovebox.

Double sided gloveboxes that are extra wide will need to have a designated side of the glovebox to achieve this distance.





Functional Work Envelope (Reaching Horizontal)



Frequent Tasks:

- Primary work envelope – 4” to 15”
- Frequent tasks- 9” to 11”

Tasks 1-2 times a day

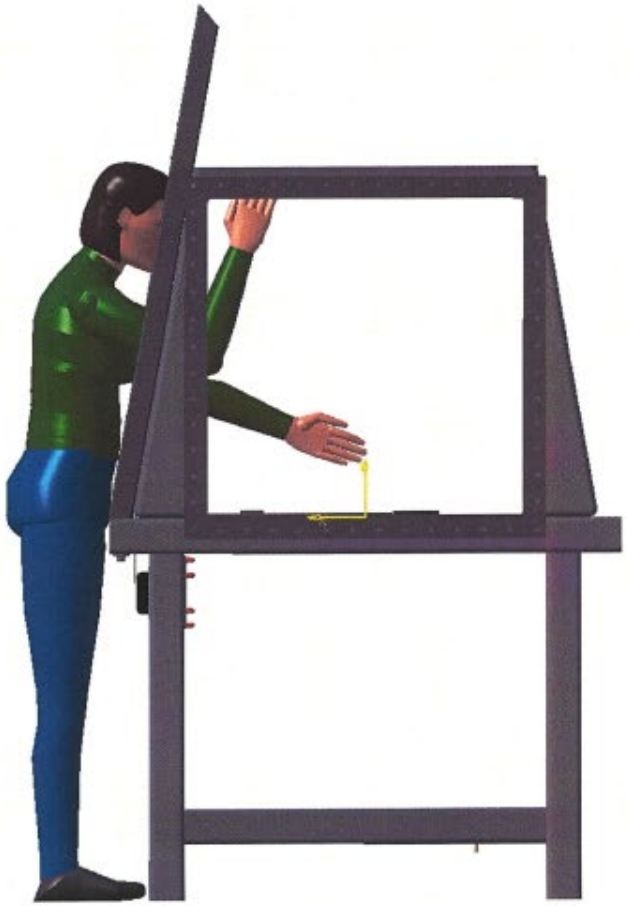
- Secondary – 15” to 22”

Less than or equal to once a week

- Tertiary – 22” to 26”

Vertical Reach: Distance from the gloveport ring apex (top) toward the ceiling.

- Primary Zone: Within 6 in
- Secondary Zone: 6 – 9 in
- Tertiary Zone: Infrequent tasks: 9 – 12 in
- Avoid: Vertical Reaches > 12 in.

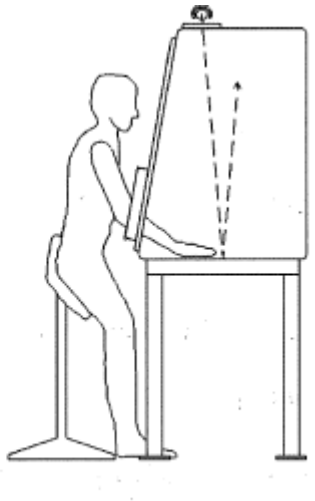


Lighting

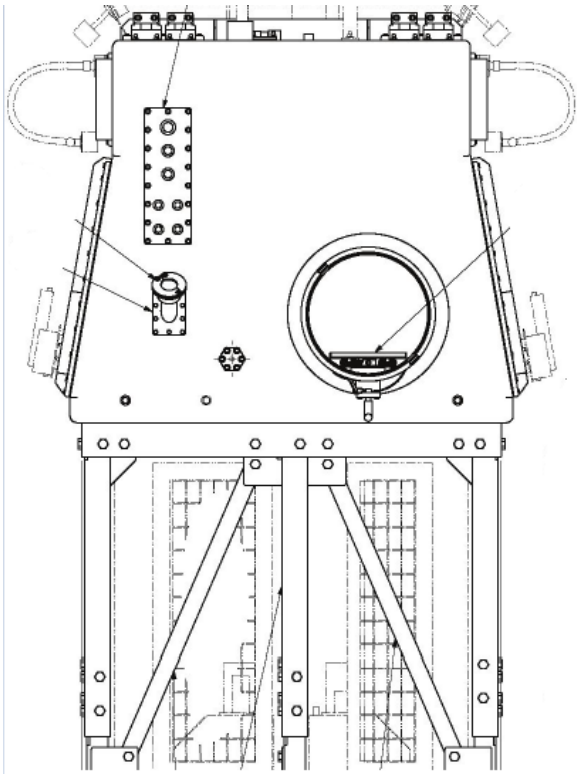
Poor lighting in GB's can lead to accidents and injury, poor lighting can be attributed to:

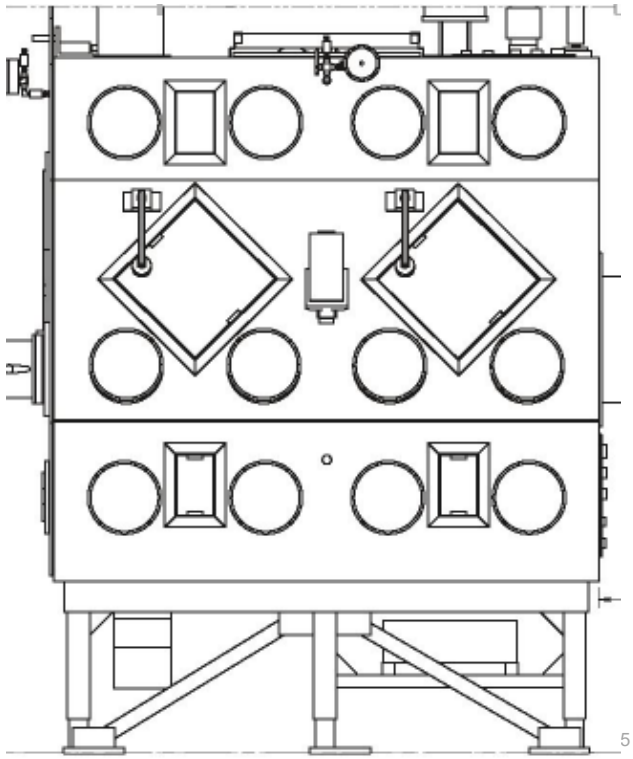
- Insufficient light
- Glare
- Improper contrast
- Poorly distributed light
- Flickering

Poor Placement



Preferred Placement





Maintenance

Maintenance can be one of the hardest aspects of glovebox work. Ensuring in the design that items that will need to replaced or fixed periodically should be within easy reaching distance for the workers in the ports.

Make/purchase fixtures such as valve handles, etc. large enough to grasp easily in glovebox gloves.

Questions?